Claims

What is claimed is:

1. A method of simulating a system, comprising:

establishing equations modeling the system using terms having characteristics encapsulated within the term;

performing symbolic processing on the established equations for simplification; and

performing system processing on the established equations for efficient simulation.

2. The method of claim 1, wherein the stage of defining equations further includes:

defining equations modeling the system using terms selected from one or more basic terms, composite terms, or collection terms.

3. The method of claim 1, further including:

extending a library of terms by defining new term classes, wherein term classes define objects having characteristics encapsulated within the objects.

4. The method of claim 1, further including:

defining a term group including one or more terms having related functionality;

evaluating each term within the term group upon an initial request for evaluation of any of the one or more terms within the term group;

storing the result of the evaluation for each of the one or more terms within the term group; and

recalling the stored value of the evaluated one or more terms from the term group upon a subsequent request for evaluation of the one or more terms, without performing the evaluation stage.

5. The method of claim 1, wherein the symbolic processing stage further includes reducing the established equations, utilizing the Pantelides algorithm, to a system of equations having a differential-algebraic system of equations index of at most one.

6. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:

assigning equations to variables that have non-zero partial derivatives; and

differentiating the remainder of the equations.

7. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:

approximating an algebraic derivative for those equations that cannot by symbolically differentiated.

8. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:

symbolically integrating equations that cannot be assigned.

9. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:

differentiating equations that add output derivates and integrating equations that add output integrals.

10. The method of claim 5, wherein utilizing the Pantelides algorithm further includes:

eliminating an integral as each symbolically differentiated or integrated equation eliminates a numeric integration, such that the integral is converted to an algebraic variable by eliminating the derivative or integral relationship.

11. The method of claim 10, wherein eliminating an integral further includes:

assigning a preferred integration location rank to one or more integrals;

utilizing the preferred integration location rank, assigning integrals to equations; and

eliminating the integration of assigned or solved integral variables.

12. The method of claim 11, wherein assigning a preferred integration location rank further includes:

assigning a preferred integration location to one or more integrals, the user assigned preferred integration location being given the highest available preferred integration location rank;

assigning a preferred integration location rank, wherein the preferred integration location rank has a lower rank than the user defined preferred integration location rank; and

assigning all other integration locations a default lowest rank.

13. The method of claim 12, wherein the assigned preferred integration location is assigned by a user.

14. The method of claim 12, wherein the assigned preferred integration location rank is assigned by a component developer.

15. The method of claim 12, wherein utilizing the preferred integration location ranks to assign integrals to equations further includes:

identifying integral variables that appear linearly and nonlinearly in the integral equations;

establishing a current preferred integration location rank at a default setting;

assigning each integral equation an integral variable that has a preferred integration location rank of less than the current preferred integration location rank, and, if possible, appears linearly in the equation; and

repeating the previous three stages after increasing the current preferred integration location rank until a maximum preferred integration location rank has been exceeded.

16. The method of claim 15, further including:

solving each integral equation that is assigned an integral that appears linearly in it;

substituting the solved value into other equations; and

if due to substitutions, an one of the assigned variables is no longer in the equation, assign another integral with minimum integration rank to the one of the assigned variables.

17. The method of claim 1, wherein the stage of performing system processing on the established equations further includes:

performing system processing on an initial condition system apart from performing system processing on a transient system.

18. The method of claim 17, further including:

defining user defined and component defined initial condition equations for the initial condition system.

19. The method of claim 17, further including:

defining numeric integration equations for the transient system.

20. The method of claim 1, wherein system processing further includes:

replacing alias variables;

partitioning the equations into blocks;

tearing the blocks;

sorting the blocks; and

compressing equation terms.

21. The method of claim 20, wherein tearing the equations includes:

identifying block variables in the equations in the block in which the block variables appear linearly with constant coefficients;

solving nonlinear integration equations for their respective integrals;

solving the linear equations;

determining the solvability of the nonlinear equations;

solving the nonlinear equations utilizing iterates and block variables solved from the linear equations; and

scanning the solved variables for identification of variables that are independent and may be removed from the block.

22. The method of claim 20, wherein block sorting further includes:

defining and identifying the blocks as static blocks, dynamic blocks, or output blocks;

removing the static blocks from a list of blocks; and

removing the output blocks from the list of blocks.

23. A machine-readable storage medium having stored thereon machine executable instructions, the execution of said instructions adapted to implement a method of simulating a system, the method comprising:

defining equations modeling the system using terms having characteristics encapsulated within the term;

performing symbolic processing on the established equations for simplification; and

performing system processing on the established equations for efficient simulation.

24. The machine-readable storage medium of claim 23, wherein the stage of defining equations further includes:

defining equations modeling the system using terms selected from one or more basic terms, composite terms, or collection terms.

25. The machine-readable storage medium of claim 23, further including:

extending a library of terms by defining new term classes, wherein term classes define objects having characteristics encapsulated within the objects.

26. The machine-readable storage medium of claim 23, further including:

defining a term group including one or more terms having related functionality;

evaluating each term within the term group upon an initial request for evaluation of any of the one or more terms within the term group;

storing the result of the evaluation for each of the one or more terms within the term group; and

recalling the stored value of the evaluated one or more terms from the term group upon a subsequent request for evaluation of the one or more terms, without performing the evaluation stage.

27. The machine-readable storage medium of claim 23, wherein the symbolic processing stage further includes reducing the established equations, utilizing the Pantelides algorithm, to a system of equations having a differential-algebraic system of equations index of at most one.

28. The machine-readable storage medium of claim 27, wherein utilizing the Pantelides algorithm further includes:

assigning equations to variables that have non-zero partial derivatives; and

differentiating the remainder of the equations.

29. The machine-readable storage medium of claim 27, wherein utilizing the Pantelides algorithm further includes:

approximating an algebraic derivative for those equations that cannot by symbolically differentiated.

30. The machine-readable storage medium of claim 27, wherein utilizing the Pantelides algorithm further includes:

symbolically integrating equations that cannot be assigned.

31. The machine-readable storage medium of claim 27, wherein utilizing the Pantelides algorithm further includes:

differentiating equations that add output derivates and integrating equations that add output integrals.

32. The machine-readable storage medium of claim 27, wherein utilizing the Pantelides algorithm further includes:

eliminating an integral as each symbolically differentiated or integrated equation eliminates a numeric integration, such that the integral is converted to an algebraic variable by eliminating the derivative or integral relationship.

33. The machine-readable storage medium of claim 32, wherein eliminating an integral further includes:

assigning a preferred integration location rank to one or more integrals;

utilizing the preferred integration location rank, assigning integrals to equations; and

eliminating the integration of assigned or solved integral variables.

34. The machine-readable storage medium of claim 33, wherein assigning a preferred integration location rank, further includes:

assigning, by a user, a preferred integration location to one or more integrals, the user assigned preferred integration location being given the highest available preferred integration location rank;

assigning, by a component developer, a preferred integration location rank, wherein the preferred integration location rank has a lower rank than the user defined preferred integration location rank; and

assigning all other integration locations a default lowest rank.

35. The machine-readable storage medium of claim 34, wherein utilizing the preferred integration location ranks to assign integrals to equations, further includes:

identifying integral variables that appear linearly and nonlinearly in the integral equations;

establishing a current preferred integration location rank at a default setting;

assigning each integral equation an integral variable that has a preferred integration location rank of less than the current preferred integration location rank and, if possible, appears linearly in the equation; and

repeating the previous three stages after increasing the current preferred integration location rank until a maximum preferred integration location rank has been exceeded.

36. The machine-readable storage medium of claim 35, further including:

solving each integral equation that is assigned an integral that appears linearly in it;

substituting the solved value into other equations; and

if due to substitutions, an one of the assigned variables is no longer in the equation, assign another integral with minimum integration rank to the one of the assigned variables.

37. The machine-readable storage medium of claim 23, wherein the stage of performing system processing on the established equations further includes:

performing system processing on an initial condition system apart from performing system processing on a transient system.

38. The machine-readable storage medium of claim 37, further including:

defining user defined and component defined initial condition equations for the initial condition system.

39. The machine-readable storage medium of claim 37, further including:

defining numeric integration equations for the transient system.

40. The machine-readable storage medium of claim 23, wherein system processing further includes:

replacing alias variables;

partitioning the equations into blocks;

tearing the blocks;

sorting the blocks; and

compressing equation terms.

41. The machine-readable storage medium of claim 40, wherein tearing the block includes:

identifying block variables in the equations in the block in which the block variables appear linearly with constant coefficients;

solving nonlinear integration equations for their respective integrals;

determining the solvability of the nonlinear equations;

solving the nonlinear equations utilizing iterates and block variables solved from the linear equations;

solving the linear equations; and

scanning the solved variables for identification of variables that are independent and may be removed from the block.

42. The machine-readable storage medium of claim 40, wherein block sorting further includes:

defining and identifying the blocks as static blocks, dynamic blocks, or output blocks;

removing the static blocks from a list of blocks; and

removing the output blocks from the list of blocks.

43. A method of symbolically processing a set of equations, comprising:

assigning a portion of the set of equations to variables that have non-zero partial derivatives;

differentiating the remainder of the set of equations;

approximating an algebraic derivative for those equations that cannot by symbolically differentiated;

symbolically integrating equations that cannot be assigned;

differentiating equations that add output derivates and integrating equations that add output integrals; and

eliminating an integral as each symbolically differentiated or integrated equation eliminates a numeric integration, such that the integral is converted to an algebraic variable by eliminating the derivative or integral relationship.

44. A machine-readable storage medium having stored thereon machine executable instructions, the execution of said instructions adapted to implement a method of symbolically processing a set of equations, the method comprising:

assigning a portion of the set of equations to variables that have non-zero partial derivatives;

differentiating the remainder of the set of equations;

approximating an algebraic derivative for those equations that cannot by symbolically differentiated;

symbolically integrating equations that cannot be assigned;

differentiating equations that add output derivates and integrating equations that add output integrals; and

eliminating an integral as each symbolically differentiated or integrated equation eliminates a numeric integration, such that the integral is converted to an algebraic variable by eliminating the derivative or integral relationship.

45. A method of eliminating an integral in a Pantelides algorithm, comprising:

assigning a preferred integration location rank to one or more integrals;

utilizing the preferred integration location rank, assigning integrals to equations; and

eliminating the integration of assigned or solved integral variables.

46. The method of claim 45, wherein assigning a preferred integration location rank, further includes:

assigning, by a user, a preferred integration location to one or more integrals, the user assigned preferred integration location being given the highest available preferred integration location rank;

assigning, by a component developer, a preferred integration location rank, wherein the preferred integration location rank has a lower rank than the user defined preferred integration location rank; and

assigning all other integration locations a default lowest rank.

47. The method of claim 46, wherein utilizing the preferred integration location ranks to assign integrals to equations, further includes:

identifying integral variables that appear linearly and nonlinearly in the integral equations;

establishing a current preferred integration location rank at a default setting;

assigning each integral equation an integral variable that has a preferred integration location rank of less than the current preferred integration location rank and, if possible, appears linearly in the equation; and

repeating the previous three stages after increasing the current preferred integration location rank until a maximum preferred integration location rank has been exceeded.

48. The method of claim 47, further including:

solving each integral equation that is assigned an integral that appears linearly in it;

substituting the solved value into other equations; and

if due to substitutions, an one of the assigned variables is no longer in the equation, assign another integral with minimum integration rank to the one of the assigned variables.

49. A machine-readable storage medium having stored thereon machine executable instructions, the execution of said instructions adapted to implement a method of eliminating an integral in a Pantelides algorithm, the method comprising:

assigning a preferred integration location rank to one or more integrals;

utilizing the preferred integration location rank, assigning integrals to equations; and

eliminating the integration of assigned or solved integral variables.

50. The machine-readable storage medium of claim 49, wherein assigning a preferred integration location rank, further includes:

assigning, by a user, a preferred integration location to one or more integrals, the user assigned preferred integration location being given the highest available preferred integration location rank;

assigning, by a component developer, a preferred integration location rank, wherein the preferred integration location rank has a lower rank than the user defined preferred integration location rank; and

assigning all other integration locations a default lowest rank.

51. The machine-readable storage medium of claim 50, wherein utilizing the preferred integration location ranks to assign integrals to equations, further includes:

identifying integral variables that appear linearly and nonlinearly in the integral equations;

establishing a current preferred integration location rank at a default setting;

assigning each integral equation an integral variable that has a preferred integration location rank of less than the current preferred integration location rank and, if possible, appears linearly in the equation; and

repeating the previous three stages after increasing the current preferred integration location rank until a maximum preferred integration location rank has been exceeded.

52. The machine-readable storage medium of claim 51, further including:

solving each integral equation that is assigned an integral that appears linearly in it;

substituting the solved value into other equations; and

if due to substitutions, an one of the assigned variables is no longer in the equation, assign another integral with minimum integration rank to the one of the assigned variables.

53. A method of tearing equations, comprising:

identifying block variables in the equations in a block in which the block variables appear linearly with constant coefficients;

determining the solvability of the nonlinear equations;

solving nonlinear integration equations for their respective integrals;

solving the linear equations;

solving the nonlinear equations utilizing iterates and block variables solved from the linear equations; and

scanning for solved for variables for identification of variables that are independent and may be removed from the block.

54. A machine-readable storage medium having stored thereon machine executable instructions, the execution of said instructions adapted to implement a method of tearing blocked equations, the method comprising:

identifying block variables in the equations in a block in which the block variables appear linearly with constant coefficients;

solving nonlinear integration equations for their respective integrals;

solving the linear equations;

determining the solvability of the nonlinear equations;

solving the nonlinear equations utilizing iterates and block variables solved from the linear equations; and

scanning for solved for variables for identification of variables that are independent and may be removed from the block.

55. A method of simulating a system, comprising:

establishing equations modeling the system using terms having characteristics encapsulated within the term;

performing symbolic processing on the established equations for reducing the number of terms in the equations; and

performing system processing on the established equations for efficient simulation.

56. The method of claim 55, further including:

defining a term group including one or more terms having related functionality;

evaluating each term within the term group upon an initial request for evaluation of any of the one or more terms within the term group; and

storing the result of the evaluation fro each of the one or more terms within the term group.

57. The method of claim 56, further including:

recalling the stored value of the evaluated one or more terms from the term group upon a subsequent request for evaluation of the one or more terms, without performing the evaluation stage.

58. A method of simulating a component, comprising:

establishing equations modeling the component using terms having characteristics encapsulated within the term;

performing symbolic processing on the established equations for simplification; and

performing system processing on the established equations for efficient simulation.